Space Weather Technical Forecast

Issued on Tuesday, 31 January 2023 at 12:37 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of G1/Minor Storms at first, declining through midweek UTC.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low throughout the last 24 hours, with only low-level C-class flare activity recorded at GOES16, peaking with a C4.9 at 31/1100UTC from newly-numbered sunspot region AR3207 near the southeastern limb. There are now five sunspots on the visible disc, with changes observed generally being of slow proliferation followed by fading of constituent spots in the four relatively simple dipoles, with the one unipolar group remaining unchanged.

Coronagraph imagery for the period shows a large high latitude Coronal Mass Ejection (CME) heading largely above and slightly ahead of the track of the Earth in its orbit. The source is not immediately obvious, however there is a large filament channel-like signature in the northwest quadrant on some extreme UV imagery (e.g. AIA 304) late in the UTC evening and through the early hours UTC. A bright field line in AIA171 extending from the northwest limb was seen to disappear in AIA171 imagery around 30/2100UTC, and the two may be related. Provisional fitting for this CME indicates that any Earth incidence will most likely be marginal if present, however model results are pending.

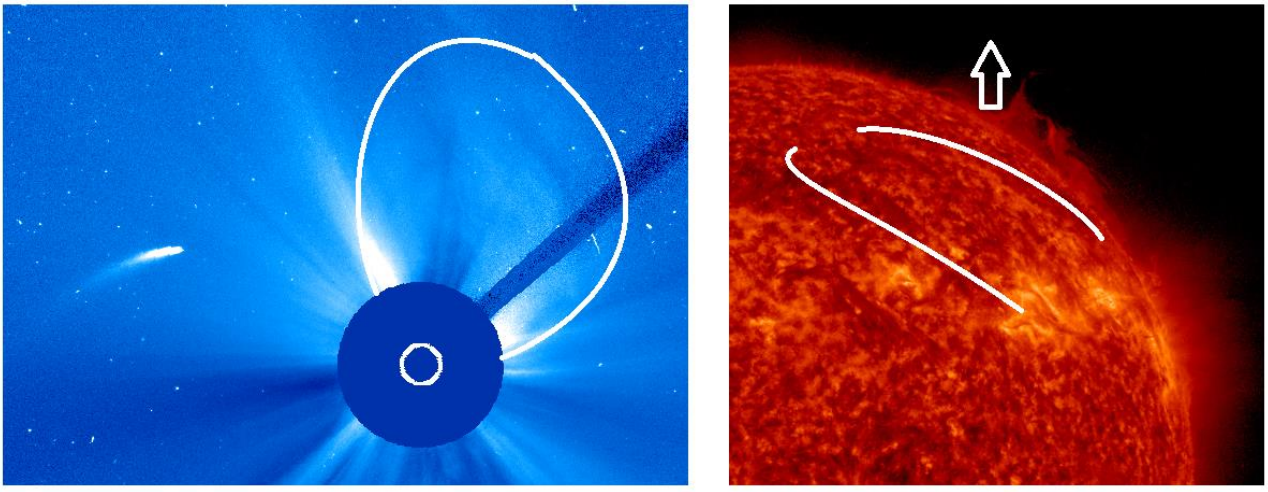

Figure 0: Lasco C3 coronagraph imagery from 31/0100UTC, showing a tentatively identified front-sided high latitude CME, possibly related to the filament channel-like signature seen in some EUV imagery (commencing earlier but peaking in brightness around the same time – AIA304 shown). Also shown (incidentally) is comet Machholz 96P.

A second, low latitude CME visible from late afternoon UTC on Monday 30 January was determined to be most likely far-sided to no effect.

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No Earth-bound CMEs therefore feature in the forecast at present, but with results for the above probable northwest filament pending.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR and ACE initially showed a slow regime, transitioning through a modest CIR into a negative polarity fast wind, with this presumed to be that emanating from CH72/-. The onset time is considered to have been around 30/2000UTC, which was earlier still than the forecast that was in turn brought forward based on STEREO A evidence. It is therefore considered likely that CH72/- is present in some form further west than it appears in AIA211 on the disc.

The solar wind speed fell initially from Slightly Elevated levels at 400km/s to a nadir at 375km/s in the preceding slow regime, before rising with the advent of the fast wind to reach a peak near Elevated 500km/s by 30/2145UTC. The solar wind density exhibited a modest rise from Background to a Slightly Elevated peak of mid-teens ppcc, falling in turn as the fast wind developed. The IMF rose from Background and 5nT to peak at 9nT before moderating a little as the period ended. The north-south component varied between -7 and +6nT in a slowly changing tendency. Finally, the phi angle was mainly negative (towards the Sun), but with a positive period mainly concentrated in the weak CIR between 30/1600UTC and 30/2000UTC.

The net effect of the above solar wind measures was for Quiet to Unsettled geomagnetic activity, with a provisional peak Kp of '3-' in the 21-24UTC window, i.e. shortly after the coronal hole's onset.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.

High energy electron flux (greater than 2 MeV) at GEO has oscillated between Normal Background and Moderate levels, peaking just shy of High flux with 998pfu recorded at GOES16 at 30/1910UTC. Associated 24-hour electron fluence has been below the Active threshold throughout, reaching 2.56e7 integrated pfu at 31/0001UTC on a steady trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be predominantly Low, with no significantly active regions on, or due to rotate onto, the visible disc, with a slight chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are forecast in the next four days, but with one CME candidate pending modelling results.

The current high speed stream from CH72/- is expected to give speeds of 450-500km/s, declining towards the end of the period. Geomagnetic activity should see a peak Slight Chance of Active or perhaps G1/Minor Storm period at first, this risk soon abating through midweek UTC to a largely quiet picture to end the current UTC working week.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is expected to remain at Background levels.

Electron flux may start exceeding the High (1e3pfu) level more frequently on diurnal highs during the next four days once CH72's geomagnetic activity subsides a little. Electron fluence values are forecast to rise towards the Active (1e8 integrated pfu) threshold in response to the increasing flux values, but on balance probably remaining below.

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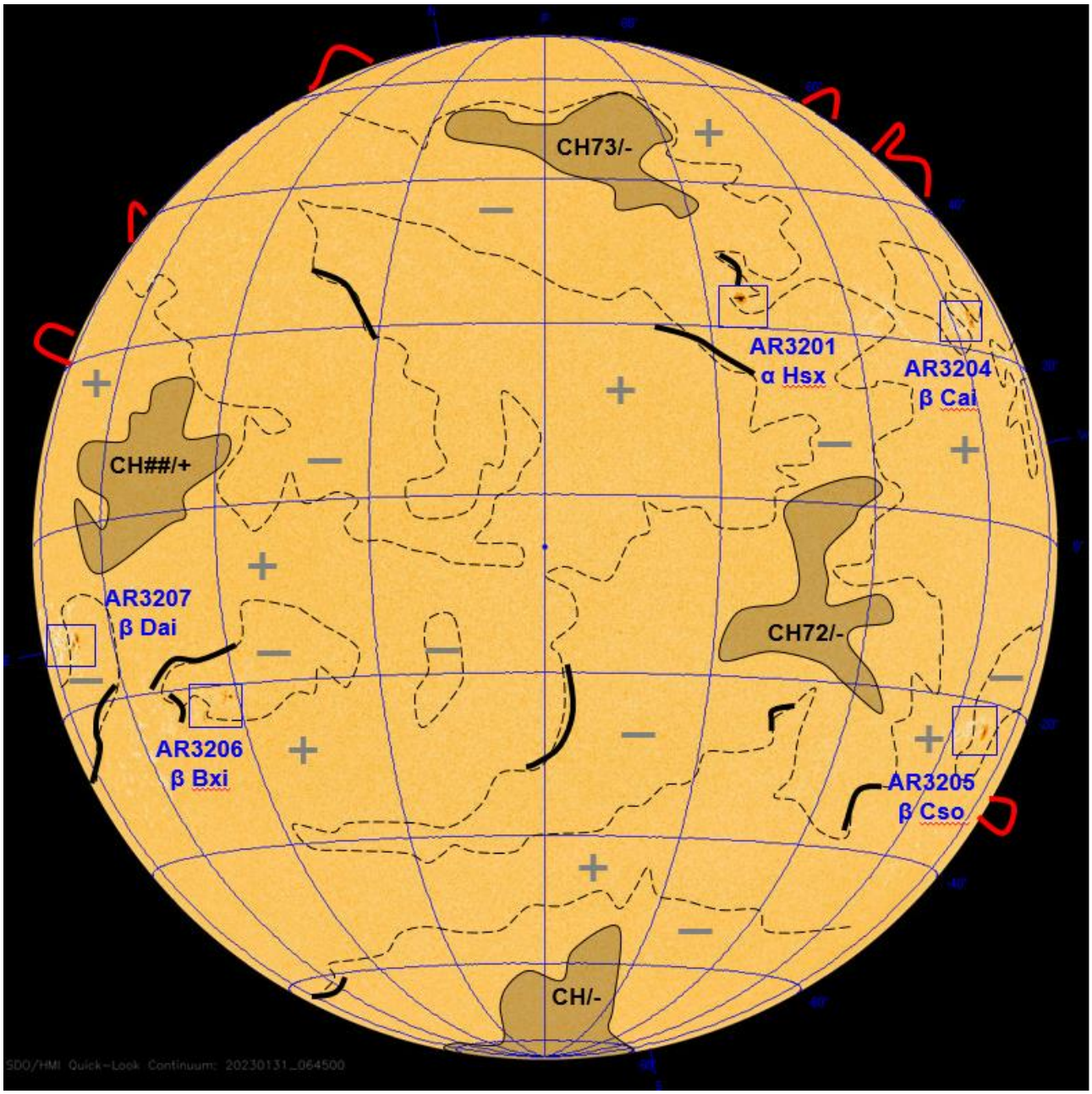
Figure 1. Solar Analysis Valid 31/0645UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are expected in the next four days, however as stated in the solar activity section, there is a potential CME candidate from the northwest quadrant awaiting modelling results.

The Earth is currently coming under the influence of a coronal hole high speed stream, most likely the equatorial coronal hole 72, but with a possible influence from coronal hole 73 in the northern hemisphere. Given the apparent early onset of the coronal hole, based on latitude and peak wind speeds, it is likely that the full area of the feature is masked by magnetic looping on satellite imagery. Both holes were evident on the last rotation, but with relatively muted geomagnetic activity. As the Earth moves towards the March equinox, the negative coronal holes tend to connect more strongly with the Earth, with an increased risk of geomagnetic storming compared to positive features. The onset of the current high speed was accompanied by a discernible CIR, although given a muted interplanetary magnetic field and slightly elevated solar wind speeds, this did not generate significant geomagnetic activity. Speeds appear to be averaging between 450-500km/s from this high speed stream, and based on STEREO A data, these speeds are likely to continue through into 01 February and consequently later into the forecast period.

Geomagnetic activity carries a residual Slight Chance of Active or perhaps G1/Minor Storms on 31 January, with any activity soon declining to become predominantly Quiet after midweek UTC.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	10	1	1	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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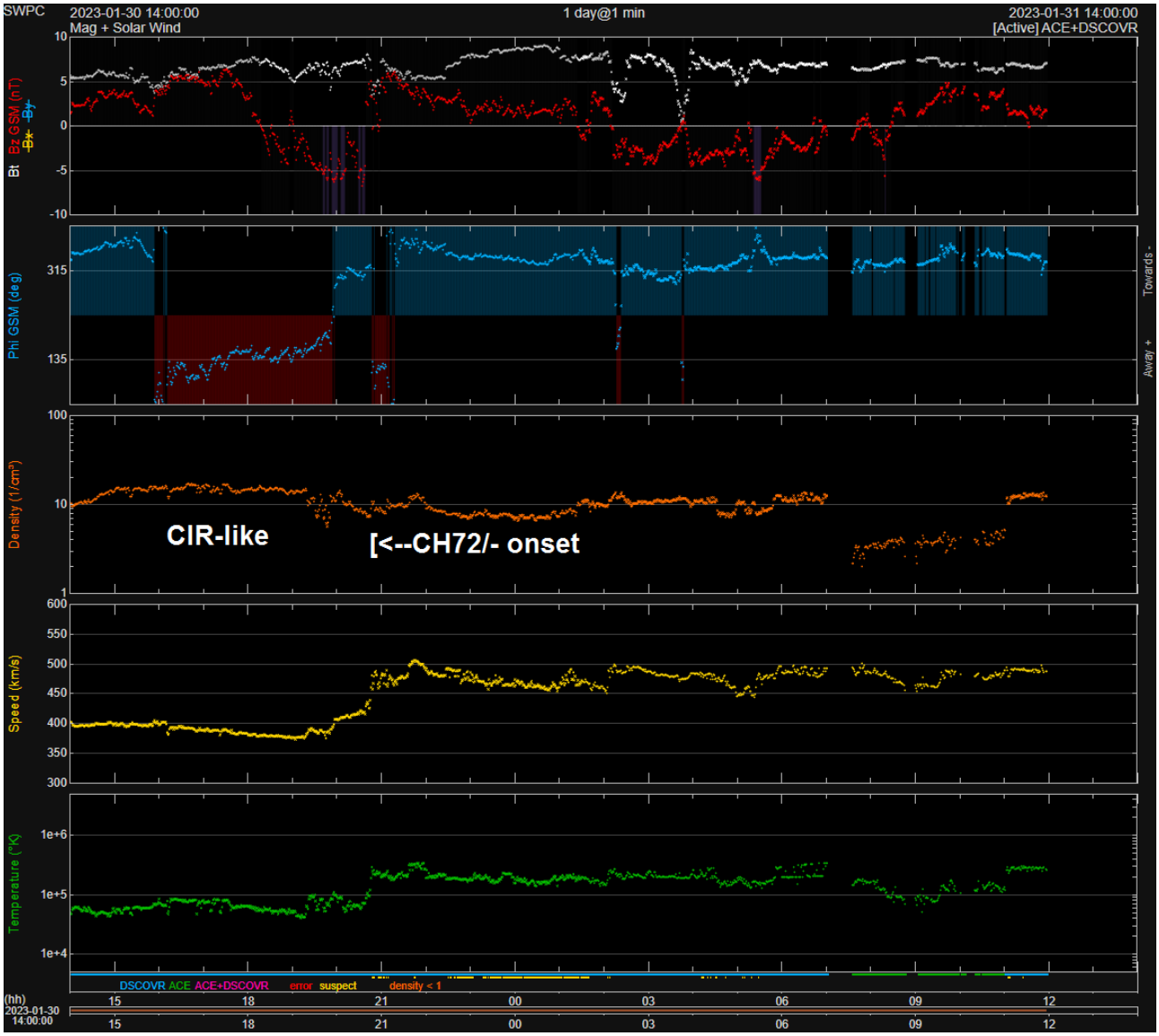
Figure 2: L1 solar wind parameters, as recorded at ACE and DSCOVR, showing CH72's onset around 30/2000UTC.



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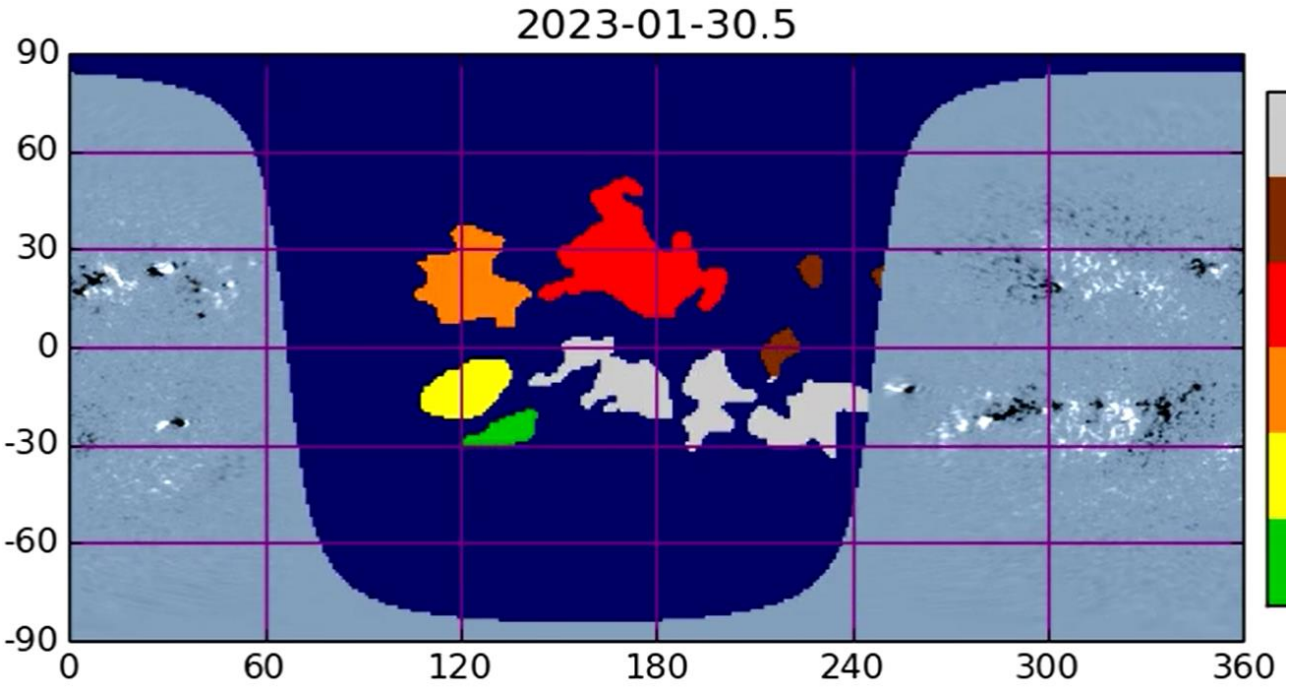
Radio Blackouts - X-Ray Flares:

There are five sunspot regions on the visible disc, with all these showing limited growth and complexity. Farsided helioseismology suggests that a number of large plage areas are due to rotate across the eastern limb through the next five days. This agrees with the forecast of a number of returning regions and visible flux on STEREO A EUVI imagery. However none of these regions close to the eastern limb have produced significant activity over the last 48 hours, which limits their impact on the current forecast.

Solar activity is forecast to be mainly Low, with a slight chance of M-class flaring.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Helioseismograph imagery from 30/1200UTC showing possible regions on the far side of the Sun at present, implying at least some southern solar hemisphere arrivals (as plages or sunspots) in the forecast period.



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is currently expected to persist at Background levels.

None of the sunspots in or due to rotate into the western hemisphere carry a significant proton storm risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to oscillate between Moderate and High levels after an initial suppression due to geomagnetic activity from CH72/-. A new stable oscillation ought to become apparent through day two, Wednesday 01 February, continuing for the remainder of the next four days (in the absence of any CME activity).

24-hour electron fluence is likely to follow an upward trend during the first half of the period, with a slight chance of reaching the threshold on 01 February, probably saturating thereafter in a steady state - again assuming no transient activity. MOSWOC REFM persists in maintaining a flat trend around an order of magnitude below the Active threshold, which may slightly understate the fluence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	20	20	20
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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